Met-Info

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The Demand for Battery Raw Materials

Metals play a pivotal role in the energy transition, as EVs and energy storage systems rely on batteries, which, in turn, require metals.

Given below is the forecast for raw material demand from batteries. It presents a base case scenario that incorporates the evolution of current policies, indicating a global temperature rise of 2.5°C by 2100. Additionally, it explores an accelerated energy transition (AET) scenario, where the world aims to limit the rise in global temperatures to 1.5°C by the end of this century.

Growing demand for metals

Lithium is a crucial material in high-energy-density rechargeable lithium-ion batteries.

The lithium fueling electric vehicle batteries undergoes refinement from compounds sourced in salt-brine pools or hard rock and quantities are measured in terms of lithium carbonate equivalent (LCE). By 2030, the demand for LCE is expected to be 55% higher in an AET scenario compared to the base case, and 59% higher by 2050. The demand for two other essential metals in battery production, cobalt and nickel, is expected to be 16% and 22% higher, respectively, in 2050 in the AET scenario compared to the base case.

Given that graphite is the primary anode material for an EV battery, it also represents the largest component by weight in the average EV. The demand for graphite in an AET scenario is anticipated to be 46% higher than in a base case scenario.

Battery materials supply chain

An accelerated energy transition would require much more capital within a short timeframe for developing the battery raw materials supply chain – from mines through to refineries and cell production facilities.

Increased participation from Original Equipment Manufacturers (OEMs) will be necessary, risking EV sales penetration rates remaining below 15% in the medium term, in contrast to approximately 40% in the total market under an AET scenario.

In addition, finding alternative sources of metals, including using secondary supply through recycling, is another option available to the industry.

However, current EV sales are too low to generate a sufficiently large scrap pool to create any meaningful new source of supply by 2030.

Source: Wood Mackenzie Newsletter, Jan. 25, 2024

Transforming e-Waste into a Resource through Battery Recycling

Global lithium-ion battery demand will increase from 700 Gigawatt hours in 2022 to 4 TWh by 2030 which amounts to $30 billion worth of investment.

The rising issue of end-of-life spent lithium-ion batteries arises from the widespread use of these batteries in everyday items like portable electronics, electric vehicles, and renewable energy storage systems worldwide. This surge in usage has led to a rapid increase in electronic waste (e-waste) generated from Lithium-Ion Batteries. For example, in 2025 there will be more than 1 billion electric cars on the road globally. In addition to this, global lithium-ion battery demand will increase from 700 Gigawatt hours (GWh) in 2022 to 4 TWh by 2030 which amounts to $ 30 billion worth of investment needed for sustainable recycling globally over five years (2025-2030).

Sustainable recycling of lithium-ion batteries

Lithium-ion batteries, the powerhouse behind the gadgets and electric vehicles, uses lithium ions for high energy density. They store renewable energy and are essential in gadgets like laptops and phones. With a lifespan of about 2,000 cycles (3-4 years), its demand is expected to expand at a compound annual growth rate (CAGR) of 9.6% between 2020 and 2030. These unsung heroes are essential to our connected, tech-driven world.

Lithium, cobalt and nickel are the main ingredient in lithium-ion batteries. While India has a supply of nickel, cobalt is scarce because most of the cobalt used comes from mines that are owned or controlled by China or the Democratic Republic of the Congo. Recycling these batteries is crucial for sustainability, aiming to recover components efficiently with minimal energy consumption and loss. This not only reduces waste but also aligns with our collective responsibility to minimize the environmental impact of our technology choices.

Although lithium-ion batteries are expensive to produce, but their profitability comes from the metals that can be recycled. Commercial recyclers provide materials compensation and responsible management, making battery recycling an economically viable option. Choosing these recyclers guarantees financial gains for businesses or individuals participating in the recycling process, as well as sustainability for the environment.

The procedures for getting rid of these used lithium-ion batteries are problematic. On the one hand, because lithium-ion battery e-waste contains complex components, the common procedures of landfilling and incinerating it create major issues about health and the environment. However, the lack of metal resources available for the production of lithium-ion batteries has raised interest in recycling as a viable alternative. In addition to addressing safety and environmental concerns, this strategy acknowledges the potential benefit of recovering valuable metals from wasted lithium-ion batteries.

In essence, the challenge lies in finding a balance between the growing need for lithium-ion batteries and the responsible management of the resulting e-waste. The transition toward recycling reflects a broader commitment to minimizing environmental impact, optimizing resource utilization, and embracing the principles of a circular economy.

India's current scenario of lithium-ion battery recycling

Lithium-ion battery recycling is still a relatively new concept in India. Currently, the conventional means of getting rid of them include incineration and landfills, both of which are bad for the environment and may cause harm to neighbouring populations. But these batteries carry some risk of their own, so it's not just the planet that's in danger. They include materials that, in the event that something goes wrong during discharging or shredding, could catch fire or even explode. Tragically, mishandling defective batteries has resulted in incidents all across the world where people were harmed and, tragically, some even lost their lives. Therefore, it's not just about being environmentally conscious; it's also about protecting our communities and ourselves from possible threats. To ensure that we handle these batteries appropriately in India, it is evident that we need to improve recycling procedures and awareness-building. Government policies like EPR in lithium-ion batteries also pushing toward recycling by linking both the manufacturers and recyclers.

Currently, the lithium-ion battery recycling industry in India is still in its infancy phase. Several producers and recyclers are emerging to cope with the increasing demand of lithium-ion batteries as well as the rising prices of raw materials. The global market for lithium-ion batteries is expected to grow at a compound annual growth rate (CAGR) of 5% through 2026, according to Transparency Market Research (TMR).

Source: International Council of Circular Economy, The Chronicle, Edition 174

Three Technologies Helping the Aluminium Industry Decarbonize

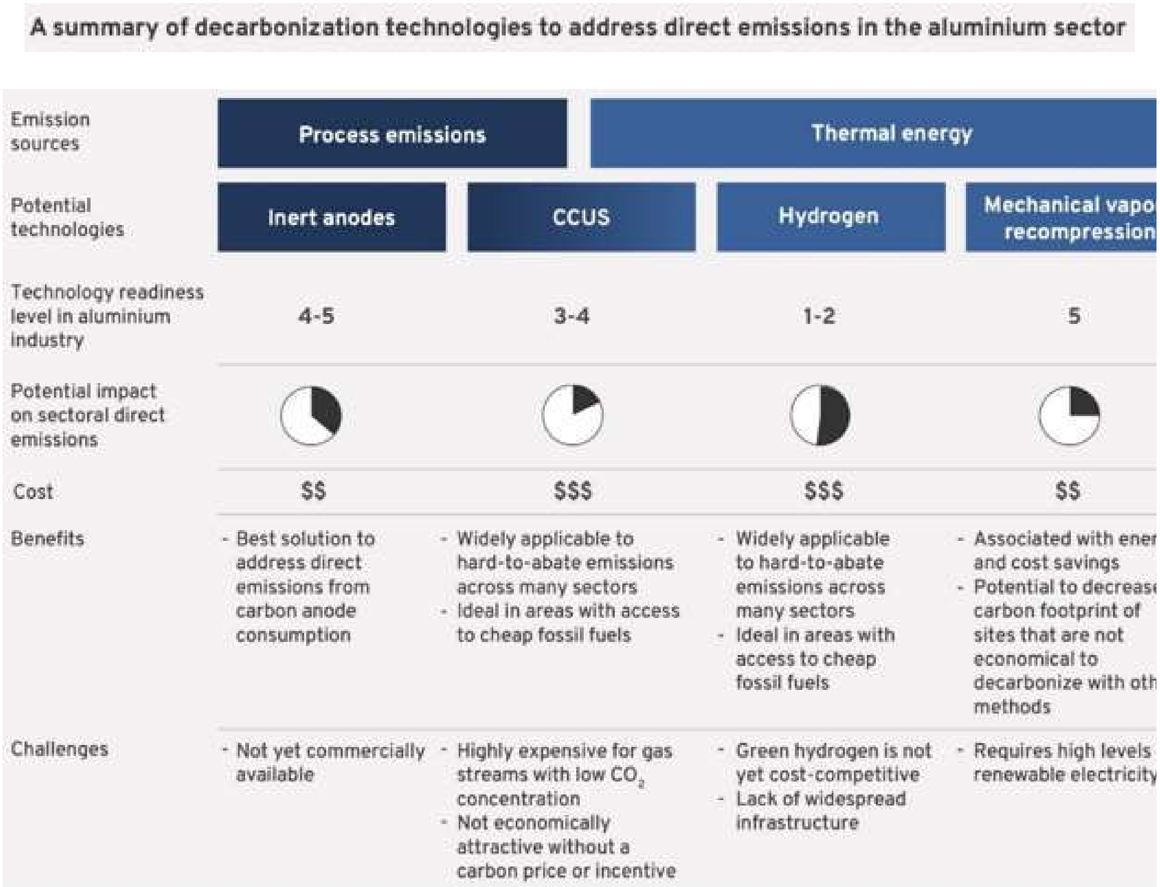
Aluminium is a vital metal for modern life. Its properties allow planes to fly, cars to move faster and the functioning of countless industries and products that define life today — from drinks cans to your smartphone.

However, it is highly energy-intensive to produce. Aluminium production emits about 3 percent of the world's direct industrial CO_2 emissions, and with demand for the metal expected to increase by almost 40 percent by 2030, greener methods of production are increasingly needed.

Aluminium's emissions challenge

Aluminium is used in multiple industries because it's lightweight, has a high strength-to-weight ratio and is good at conducting electricity and heat.

It's also 100 percent recyclable, making it a valuable metal for sustainable practices and a critical component of the energy transition, used for renewable energy infrastructure, transmission lines, energy storage and in the manufacturing of electric vehicle (EV) components.



A summary of decarbonization technologies to address direct emissions in the aluminium sector

Emission sources	Process emissions	Thermal energy		
Potential technologies	Inert anodes	CCUS	Hydrogen	Mechanical vapo recompression
Technology readiness level in aluminium industry	4-5	3-4	1-2	5
Potential impact on sectoral direct emissions				
Cost	$$	$$$	$$$	$$
Benefits	- Best solution to address direct emissions from carbon anode consumption	- Widely applicable to hard-to-abate emissions across many sectors - Ideal in areas with access to cheap fossil fuels	- Widely applicable to hard-to-abate emissions across many sectors - Ideal in areas with access to cheap fossil fuels	- Associated with ener and cost savings - Potential to decrease carbon footprint of sites that are not economical to decarbonize with oth methods
Challenges	- Not yet commercially available	- Highly expensive for gas streams with low CO_2 concentration - Not economically attractive without a carbon price or incentive	- Green hydrogen is not yet cost-competitive - Lack of widespread infrastructure	- Requires high levels renewable electricity

Tackling aluminium emissions will require the swift development of decarbonization tech. Although the intensity of emissions from aluminium production is decreasing, it needs to fall much faster if we are to reach net-zero emissions by 2050.

Reducing emissions from aluminium production

As with so many decarbonization initiatives, collaboration plays an important role in facilitating change.

The Mission Impossible Partnership, in collaboration with the International Aluminium Institute, has released an *aluminium decarbonization roadmap* that details what the industry could look like in a zero-carbon world, and what needs to be done to get there.

In addition, members of the World Economic Forum's *First Movers Coalition* — a global initiative to harness the purchasing power of companies to decarbonize the planet's heaviest-emitting industries — have committed to procuring at least 10 percent of the aluminium they use from near-zero emissions processes by 2030.

As collaborations and pledges help the industry decarbonize, so too will technological innovation, and the industry is poised for a number of breakthroughs that could dramatically reduce emissions.

1. Technology to decarbonize aluminium smelting

Norway's aluminium and renewable energy firm *Hydro* recently received an award at the 2023 UN Climate Change Conference in the United Arab Emirates for its pioneering work on green aluminium. The proprietary technology could fully decarbonize aluminium smelting.

The company is working on offering a different type of technology to replace the Hall-Héroult process. Instead of emitting CO_2 during the electrolysis stage, Hydro's HalZero technology keeps the carbon and chlorine in a closed loop, eliminating CO_2 emissions and emitting only oxygen.

The current goal is to reach industrial-scale production by 2030, with the first aluminium produced by 2025.

2. Purer recycled aluminium

Recycling aluminium uses 95 percent less energy than producing aluminium from raw materials, and is often cheaper, making it a viable route to speed up decarbonization of the industry.

Until recently, however, recycled aluminium often contained impurities or alloying elements that affected its quality and restricted its use in things such as high-precision electronic components in medical devices or EVs, for example.

But researchers in the U.S. are working on an innovation that removes metal impurities from recycled aluminium, allowing it to be used for more applications and increasing its sustainability. While specific details on the solution remain confidential, it is being created with the support of a 170-member public-private partnership funded in part by the United States Department of Energy.

Recommended steps to begin aluminium industry decarbonization

Independent actions

1. Work internally to understand the current state of operations and baseline emissions
2. Set internal targets to decarbonize
3. Work backwards from target dates to understand the key activities and initiatives required to reach decarbonization goals
4. Define the business case for renewables and develop a plan to transition captive or grid power sources
5. Work with local governments to support and define decarbonization policy

Collaborative actions

1. Collaborate alongside other aluminium producers to address electrolysis emissions through the development of inert anode technology
2. Collaborate alongside other aluminium producers to decarbonize captive power sources and industrial heat and steam generation through CCUS and/or renewables
3. Collaborate with value-chain partners to improve the circularity of aluminium through improved scrap collection and sorting methods
4. Work as an industry to influence global decarbonization policy to drive common standards and markets for low-carbon aluminium
5. Take an active role in supporting the energy transition by engaging energy partners and other heavy industries to address the need for renewables
6. Develop a standardized framework to calculate, monitor and report carbon emissions and the value/success of reduction efforts
7. Work alongside partners to address emissions across the value chain (e.g. transport, waste processing) to reach net zero

3. Replacing fossil fuels with hydrogen

Australian mining group Rio Tinto is working with the Australian Renewable Energy Agency (ARENA) to evaluate whether hydrogen can be used as an alternative to natural gas in refineries for alumina (a starting material for the smelting of aluminium).

If fossil fuels can be replaced with clean hydrogen in the refining process for alumina, this will reduce emissions in the energy and emissions-intensive refining stage of the aluminium. Exploring these new clean energy technologies and methods is a crucial step towards producing green aluminium.

Source: GreenBuzz Weekly, Jan. 16, 2024

Green Steel: Locational Advantages and Challenges

To produce green steel using low-emissions H_2-DRI-EAF technology, a substantial quantity of green hydrogen and continuous zero-emission electricity are required.

H_2-DRI-EAF involves the use of hydrogen (H_2) to produce direct reduced iron (DRI) which is then consumed in an electric arc furnace (EAF) to produce steel. Regions with strong renewable energy resources will be able to produce cheap green hydrogen in the future, but they will require considerable investment in dedicated solar and wind installations.

In the short term, the need for non-stop zero-emissions electricity is enticing steelmakers to regions where lower-emissions grid electricity is already available, including locations in Norway, Brazil, northern Sweden, and the Canadian province of Quebec.

Nordic countries are leading the way in the deployment of renewable energy and boast some of the lowest carbon intensity levels in their power generation.

With the majority of their electricity generated from hydro sources, countries such as Norway or regions like the north of Sweden enjoy a distinct advantage – the ability to provide a continuous, uninterrupted low-emissions electricity. This consistent energy supply can effectively meet the electricity demands around the clock of both steel mills and the electrolysis process needed to make green hydrogen.

H_2 Green Steel (H_2 GS) is constructing its first plant in Boden, north Sweden, where access to cheap, dependable clean energy from the grid means it can procure electricity via power purchase agreement (PPA) contracts with renewable power providers. This set-up delivers significant cost savings in capital expenditure, as there is no requirement for investments in renewable energy infrastructure and excessively large electrolysis.

H_2 GS has signed a seven-year supply contract for 2 terrawatt-hours (TWh) per year of fossil-free electricity with Statkraft, to commence in 2026. Norway's Statkraft, one of the frontrunners in supporting industry transition, will supply nearly 30% of the energy that H_2 GS requires for electrolyser.

H_2 GS and Fortum have established a partnership to supply carbon-free electricity. This includes an index-based PPA of 1.3TWh starting in 2026, with a five-year hedging horizon, and a fixed-price PPA of 1TWh lasting up to nine years from 2027.

Blastr Green Steel is another Nordic green steel initiative. In October it signed a Letter of Intent (LOI) with power supplier *Sogn og Fjordane Energi* (SFE) to power its planned pelletising plant in Norway. The clean electricity will be based on hydro and wind power.

For many years, *location models* have focused on minimising the distance to the end users or raw material sources, but now proximity to renewable energy sources is shaping a new paradigm in the steel sector.

H_2 GS is exploring plans to build a new green iron facility in Quebec, which enjoys rich hydropower capacities. Quebec's power grid is 94% hydro and 5% wind power. H_2 GS is negotiating for hydroelectricity allocation to its potential green iron project in Quebec. While the 700MW of electricity capacity it requires is only 1.5% of the total 46GW capacity in that province, peak demand during winter is a bottleneck that can necessitate consumption of some gas-fired power. In its search for other geographies, the company has also signed an agreement with Vale to investigate opportunities in the green iron ore value chain in Brazil and North America, focusing on locations that have access to green electricity.

Although building new green iron or green steel plants in locations with existing hydropower plants is advantageous, it is not the ultimate solution for green steel transition. Hydropower availability located close to iron ore reserves is limited, and more renewable development based on solar and wind is needed to supply the energy for the green steel transition.

For one tonne of steel produced via H_2-DRI-EAF, nearly 3.6 MWh of electricity is required. To produce green steel of the same scale as H_2 GS using a solar photovoltaic (PV) utility with a 20% capacity factor – irrespective of the plant's location, and without relying on battery storage for hydrogen production – the electrolyser's size should be increased by a factor of 3.5, and this augmentation must be supported by solar utility oversized by a factor of 5. In this configuration, hydrogen storage and batteries are essential to ensure seamless operation. This inevitably requires increased capital expenditure.

Studies by the Minerals Research Institute of Western Australia (MRIWA) show that scaling up power facilities (including 50/50 solar and wind plus batteries) for 1Mtpa of crude steel capacity requires A$5.6 billion (almost US$3.6 billion) which is more than cumulative investments needed for pelletising, DRI plant, EAF and even electrolysers to produce hydrogen.

The forthcoming wave of green steel initiatives can be strategically situated in areas with access to very low-cost renewable energy sources. Each of these green steel projects can adopt a tailored configuration to minimise investments in renewable energy and hydrogen infrastructure, while also maximising the utilisation of existing capacities.

At the COP28 global climate summit, 116 countries endorsed the Global Renewable and Energy Efficiency Pledge, making a commitment to tripling renewable energy generation capacity by 2030. If realised, this commitment has the potential to pave the way for dedicated green hydrogen production for green steelmaking.

Countries in the Middle East and North Africa (MENA) region can increasingly transition to green iron and steel production, leveraging cost-effective energy from solar and wind sources.

Even presently, several areas in Australia have the capacity to meet most of their energy needs through renewable sources – such as South Australia and Tasmania.

South Australia has set an ambitious goal to achieve 100% net renewable energy by 2030. By 2022, it had reached nearly 70% reliance on renewables. The state will likely achieve 100% years before its target, maintaining an average 99.8% renewable supply over a seven-day period in October. However, an opportunity is arising as some of the generated electricity is currently being curtailed in the middle of the day when solar generation is at its maximum, due to low demand in the market.

The state has a strategy to harness this energy for generating hydrogen, which can then be utilised to produce electricity when demand arises. While generating electricity from hydrogen incurs high energy loss and has nearly 30% round trip efficiency, given the proximity of the hydrogen electrolyser to the Whyalla steelworks – currently transitioning from coal-consuming blast furnaces to the DRI-EAF pathway – the hydrogen can be employed in ironmaking processes more efficiently than electricity generation.

Moreover, given their declining cost, batteries present the capacity to address any supply gaps and ensure the continuous delivery of green energy from renewables to end-users. BHP has signed a PPA with Neoen, guaranteeing a 24/7 supply of 70MW electricity from wind farms firmed by batteries to the Olympic Dam mine. Synergy, a state-owned utility, has received approval to build Australia's largest battery in Western Australia, featuring a substantial 500MW, four-hour (2,000MWh) storage capacity.

Tasmania stands out as another promising candidate for the iron and steel transition, boasting the most dependable renewable power supply in the country. The state depends mostly on dispatchable hydro power, without any reliability gap issues in coming year. The state is home to the Savage River magnetite iron ore mine and the 2.2 million tonne pelletising plant at Port Latta, both operated by Grange Resources. By adopting the strategy employed by H_2 GS, Tasmania has the potential to become a pioneering Australian green iron producer.

Producing green steel is an energy-intensive process, posing a challenge for steelmakers striving to embrace low-emission technologies like H_2-DRI-EAF. The shift toward truly green steel using green hydrogen is expected to start in regions where the power grid is already dominated by clean electricity production. This will see such steelmakers set a high green steel benchmark that other countries and regions will need to compete with.

Source: IEEFA Friday Week in Review; Jan. 13, 2024

H_2 Green Steel Signs $130m Seven-year Supply Deal for Green Hydrogen-derived Steel with Major Auto Parts Maker

A major auto parts supplier has agreed to buy "near-zero-emission steel" from Swedish start-up H_2 Green Steel (H_2 GS) for seven years in a deal worth $130m.

German firm Kirchhoff Automotive says its customers - which include BMW, Mercedes, Ford and Porsche — want to buy components with lower emissions.

Kirchhoff Automotive — which makes chassis parts for auto makers including BMW, Mercedes-Benz, Ford, Volkswagen, Audi, Skoda and Hyundai — will start receiving green steel made using green hydrogen and renewables-powered electric arc furnaces from 2027.

H_2 GS plans to manufacture five million tonnes of green steel annually by 2030 in a purpose-built facility in the town of Boden, northern Sweden, which is due to come on line next year. It will also produce its own green hydrogen from around 1 GW of electrolysers, and last May ordered more than 700 MW of alkaline machines from German manufacturer Thyssenkrupp Nucera.

Replacing grey steel made using coal with the more expensive green variety will cost about €300 ($326) per car, according to estimates — an increase that can be fairly easily absorbed by customers already paying five figures for new vehicles.

Kirchhoff and H_2 GS have also agreed to work together to ensure that at least 30% of its steel scrap volumes will be sent back to Boden for recycling.

The Swedish company has previously signed binding offtake agreements for green steel with Mercedes-Benz, Porsche, truck maker Scania, US conglomerate Cargill, German auto technology firm ZF, Italian steel maker Marcegaglia, UK-based SPM and Germany's Bilstein Group.

H_2 GS secured €4.55 bn of financing from European banks and export credit agencies in October 2022, and said in September last year that it had raised €1.5 bn in equity. Groundworks at the Boden site have begun, but H_2 GS is yet to make a final investment decision on its plant — despite having been expected to do so by the end of last year. The steel due to be produced in northern Sweden will not be fully emissions-free as the company plans to use pelletised iron ore shipped from Brazil and Canada - resulting in embedded emissions of about 40-50 kg of CO_2 per tonne of steel produced. But H_2 GS points out that this will be more than offset by the 1,800-1,900 kg of CO_2 emissions per tonne of steel avoided by its process.

Kirchhoff has 27 plants in 11 countries around the world, including the US, China, Canada, Mexico, Germany, Poland, Hungary, Romania, Spain, Portugal and Ireland.

Source: Accelerate Hydrogen <newsletter; Jan. 18, 2024

ArcelorMittal Commissions $35 m Bio-coal Plant

ArcelorMittal has commissioned a €35 million bio-coal plant in Ghent, Belgium, the first of its kind in the European steel industry. The plant will process waste wood into bio-coal, suitable for its blast furnace process at its Ghent plant. The steelmaker estimates a reduction of annual carbon emissions by 112.5 kt, with the Torero plant converting 88 kt of waste wood into 37.5 kt of bio-coal each year.

The use of bio-coal in the blast furnace process will produce biogas which will be transformed into ethanol by the Steelanol facility. This can then be used as a building block to produce a variety of chemical products including transport fuels, paints, plastics, clothing and even cosmetic perfume. ArcelorMittal Belgium has the ambition to decarbonize its steel production, and is fully engaged in implementing an action plan to reduce CO_2 emissions by 35% by 2030 compared to 2018 and to become climate neutral by 2050. This fits perfectly with their XCarb® programme that brings together all of ArcelorMittal's products and steelmaking activities with reduced, low and zero carbon emissions, as well as broader initiatives and innovation projects, into a single effort aimed at achieving demonstrable progress toward net zero carbon steel.

Source: Weekly News from Steel Times International, Jan. 10, 2024

Reducing Costs: The Key to Leveraging Green Hydrogen on the Road to Net Zero

As the dust settles on the 2023 United Nations Climate Change Conference (COP28) and countries begin heeding the clarion call to transition away from fossil fuels in energy systems "in a just, orderly, and equitable manner," it's worth reflecting on what it will take to achieve net zero, especially for countries like India that heavily depend on energy imports and are just beginning their developmental trajectory.

In 2021, I spoke about an "equitable" transition at the Global Investor Summit in London before COP26, and it's encouraging to see the word "equitable" in the COP28 headline statement.

When we commissioned our first solar project in 2011, a 40 megawatt (MW) installation in Bitta, Gujarat, the initial tariff was 15 INR per kilowatt-hour (kWh) (almost $0.30) while the panel efficiency was 14-15%. Today, the lowest tariff in India is as low as 1.99 INR per kWh ($0.024), and the panel efficiency is 23%. Advances in material science will further improve efficiency.

While renewables like solar and wind have come a long way, their intermittent nature requires energy storage solutions for when the sun isn't shining and the wind isn't blowing. Decarbonization of industry, heavy-duty transportation and chemicals require a green molecule to replace fossil fuels. Green hydrogen, derived from water electrolysis using renewable energy, is the answer to both.

Viability of green hydrogen

Hydrogen has been known as a potential energy storage medium for over a century. It can produce electricity in fuel cells with water as the only waste product or through combustion in turbines without carbon dioxide (CO_2) emissions. It's a feedstock for fertilizers and chemicals. However, almost all hydrogen today is produced from fossil fuels, emitting nearly a billion tons of CO_2 equivalent each year.

In contrast, green hydrogen is a clean fuel, a scalable energy storage solution and a zero-emission industrial feedstock. For green hydrogen to fulfil these roles, the cost of production must decline similarly to renewables. That can only happen if the renewable cost of production falls faster than that of green hydrogen, given that 60-70% of green hydrogen's cost is from electricity.

For India, green hydrogen presents a home-grown opportunity as it holds the promise, along with renewables, to lift the yoke of expensive energy imports from its economy – more than $230 billion per year (19.1 trillion INR) for crude imports.

Broadening adoption

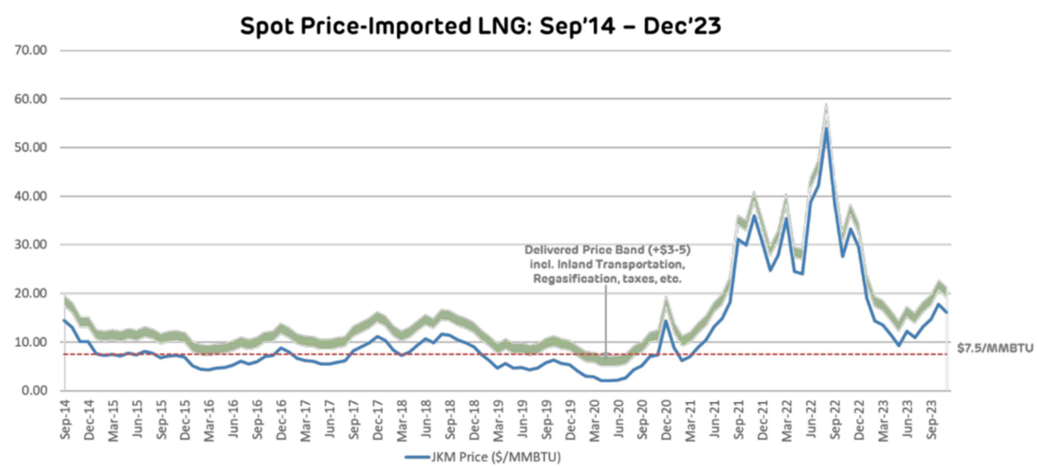
Responsible businesses are electrifying operations in their quest for net zero, adopting biofuels and proactively sourcing renewables. While battery electric vehicles will significantly contribute to emission reduction in mobility, other solutions may be needed for heavy-duty transportation.

Biofuels are a carbon-neutral alternative to fossil fuels but are unavailable in sufficient quantity. Green hydrogen and its derivatives – methanol and ammonia – have the potential to address these challenges. Green hydrogen may be the last mile in the net-zero journey for many sectors, especially in India.

However, the cost of green hydrogen must significantly decrease from the current $3-5 per kilogram (kg) for widespread adoption. With a declining cost of production, green hydrogen will progressively become a clean alternative to fossil fuels in many applications. At $1/kg – equivalent to $7.5 per million British thermal units of heat (MMBtu) – it will be economically viable to decarbonize even the most challenging sectors without a burdensome carbon price.

Overcoming production challenges

The viability of green hydrogen is particularly relevant for India, which lacks significant proven sequestration reserves, making carbon capture and storage unfeasible. Moreover, the price of imported liquefied natural gas has hovered around $7.5/MMBtu or higher over the past decade, not including additional costs for inland transportation, regasification and various taxes, leaving the country vulnerable to the dollar.



The initial challenges associated with hydrogen transportation mean that the early focus for trade is likely to be on derivatives like green ammonia and methanol. Hydrogen hubs, where the production, use and export of green hydrogen and its derivatives are co-located, are also being promoted.

Internationally, policy measures are being introduced to fast-track green hydrogen:

- Enabling faster permitting for renewables.
- Aggregating demand for offtake (an agreement to buy the green hydrogen).
- Providing contracts for difference to address initial viability gaps.

- Introducing production-linked incentives for equipment manufacturing.
- Creating certainty of demand via mandates for the progressive adoption of green hydrogen.

Innovation, particularly improving electrolyzer efficiency, will also play a role. A strict definition of green hydrogen and its derivatives regarding total allowable emissions will enable a price premium, unlocking investment. The GH2 Green Hydrogen Standard is a step in the right direction.

Vertical integration approach

However, reducing costs will require a relentless focus on vertical integration at scale. The most significant near-term reductions will come from large-scale, vertically integrated projects encompassing the entire supply chain. These projects will include giga-scale manufacturing of solar modules and their ancillaries, wind turbines, electrolyzers, in-house engineering, procurement and construction capabilities and the production of green hydrogen and its derivatives – all in a single location.

Moreover, if this location is also a port with an adjacent industrial ecosystem, encompassing the entire flow of goods and services from source to end consumption, that utilizes green hydrogen and has the infrastructure to export hydrogen derivatives, it can mitigate some early challenges related to long-term storage and transportation. Such mega-projects will enhance execution speed and reduce costs due to fewer intermediaries.

This approach is highly capital-intensive, and vertical integration carries its own risks, such as changes in technology. However, it also promises the greatest acceleration towards the $1/kg mark. It is crucial that discussions on climate finance consider the capital needs of such large integrated projects, particularly for developing countries, where the cost of capital has been a perennial challenge despite businesses being willing to take the risk.

An equitable solution

Certainly, adopting green hydrogen-based decarbonization solutions will require early experimentation, investment in infrastructure and continued improvement in learning curves for technologies such as fuel cells and hydrogen turbines. Yet, as the $1/kg milestone becomes attainable, new business models will emerge and mechanisms such as carbon pricing – capturing the external costs of greenhouse gases – will become more effective in accelerating adoption.

For India, the equitable solution is not to replace one fossil fuel with another but to leapfrog to renewables and green hydrogen. The decrease in solar costs can be replicated with green hydrogen. This shift will help India achieve energy security and improve air quality in its cities. It will also contribute to food security by eliminating the uncertainties of imported ammonia prices, a crucial component in fertilizers. Most importantly, it will offer the world a chance to avert the adverse impacts of climate change.

Source: Excerpts from Address of Mr. Gautam Adanl, Chairman, Adani Group, World Economic Forum Annual Meeting, Jan 16, 2024

World's First Major Green Steel Project Locks Down $5B in Funding

Swedish firm H_2 Green Steel says construction is "well underway" at its first-of-a-kind facility. It aims to start churning out low-carbon steel in late 2025.

The first step to removing fossil fuels from steelmaking is to build facilities that can produce the all-important alloy with little to no carbon emissions. And the first step to building those new facilities is to lock down billions and billions of dollars in project financing.

H_2 Green Steel, the Swedish company developing what would be the world's first large-scale green steel plant, has done exactly that.

The firm announced that it has achieved a "massive milestone," finalizing a 4.75-billion- euro ($5.17 billion) investment. The financing, which is mostly debt, comes just months after the firm announced a €1.5 billion ($1.6 billion) equity round.

Steelmaking, essential for building everything from bridges to utility-scale solar arrays, is one of the most carbon-intensive processes on the planet. It alone accounts for somewhere between 7 and 9 percent of global carbon emissions. The sector relies heavily on coal-fired blast furnaces and is notoriously tough to decarbonize.

One potential path to removing fossil fuels from the process of making steel is to use clean hydrogen instead of coal. But this approach has not yet been demonstrated at an industrial scale.

H_2 Green Steel aims to change this with its in-progress facility in Boden, a city in northern Sweden. The company says construction of the green steel plant is now "well underway," and that it has locked down supply contracts, electricity power-purchase agreements and, most importantly, binding customer agreements for "half of the initial yearly volumes of 2.5 million tonnes of near zero steel."

If construction goes as planned, the facility will begin churning out green steel for these customers by the end of next year or early 2026. By 2030, H_2 aims to scale its annual production capacity to 5 million metric tons. These are ambitious figures, though just a drop in the bucket of global steel production; each year, the world produces nearly 2 billion metric tons of the crucial material.

Commitment to reach net zero by 2050 requires this sector to undergo transformative changes. The project paves the way for the development of environmentally friendly steel - crucial for the decarbonization efforts of the so-called 'hard-to-abate' steel sector

The debt portion of the financing, amounting to €4 billion ($4.35 billion), comes from a group of more than 20 lenders that includes government entities such as the European Investment Bank and major banks such as BNP Paribas. H_2 also added nearly €300 million ($327 million) in new equity funding from a group of both new investors, like Microsoft Climate Innovation Fund, and existing shareholders, such as Just Climate. The company signed a €250 million ($272 million) grant agreement with the European Commission's Innovation Fund as well.

Total funding for the facility is now €6.5 billion ($7.08 billion), a significant sum for a novel project.

The sheer size and innovative structuring of the financing package matches the scale and complexity of this landmark project. The way H_2 Green Steel has raised and de-risked this first-of-its-kind financing is a template for others to study."

The private equity firm behind the H_2 project, Vargas Holding, has managed to pull together this much money in large part because it has already locked in a number of credible customers for the green steel. In 2022, the firm announced preorders from blue-chip companies like BMW and Mercedes-Benz as well as from primary steel suppliers like Bilstein Group. The Swedish National Debt Office has also agreed to provide a "green credit guarantee" that backstops billions of dollars of debt financing.

In addition to pioneering a new way to produce steel at an industrial scale, the firm is also planning to secure its access to clean hydrogen by building out an unprecedented amount of electrolyzers, the machines used to produce carbon-free hydrogen from water and electricity. The facility's 700 megawatts' worth of electrolyzer capacity is a major undertaking in itself: It represents one of Europe's largest clean hydrogen commitments to date.

H2 Green Steel is far from the only green steel project in the world — nor is hydrogen-based steel the only potential path for decarbonizing the industry — but it may well be the facility that offers the world its first true look at the future of steel.

Source: Canary Media, 23 Jan. 2024

Big Iron Ore Producers' Long-term Strategies Diverging in the Face of Steel Decarbonisation

Growing steel decarbonisation momentum is prompting three of the big four iron ore miners to increase supply of high-grade iron ore. The other is more focused on floundering carbon capture technology, while investor pressure on Scope 3 emissions continues to build.

Much of the focus on the outlook for iron ore naturally emphasises shorter-term economic performance and steel demand in China – by far the largest importer of iron ore globally. China is the destination for 85% of Australia's iron ore exports.

However, along with declining long-term steel demand and plans for increased recycling of scrap steel, there is another trend emerging in China. In January 2024, it was announced that China Baowu – the world's largest steelmaker – has begun commercial-scale production of direct reduced iron (DRI) in Guangdong province. Using Energiron technology, the plant has been built hydrogen-ready.

Green hydrogen-based DRI has emerged globally as a key technology to reduce primary steelmaking emissions, which also constitute the great majority of iron ore miners' Scope 3 emissions. However, DRI production requires a higher grade of iron ore with a greater iron (Fe) content than that used in coal-consuming blast furnaces. Direct reduction (DR)-grade ore has an Fe content of 67% or more. A global steel industry shift from blast furnaces towards DRI will drive a significant shift in the quality profile of traded iron ore.

China Baowu's project is the second commercial-scale Energiron DRI plant to begin operations in China, after HBIS started production at its plant in 2023. China is targeting peak steel sector emissions by 2030 but looks like it is well ahead of schedule.

The emergence of commercial-scale DRI production in China mirrors European steelmakers' growing shift towards technology that doesn't use coal and is already hydrogen-ready.

Meanwhile, Asian steelmakers including Japan's Kobe Steel and JFE Steel are targeting DRI production in the Middle East, which is already an established user of mature DRI technology.

The global steel technology shift away from blast furnaces is accelerating and demand for suitable iron ore is set for significant growth. DR-grade ore makes up only a small fraction of overall iron ore trade, and Australian iron ore miners have long focused on lower-iron content, blast furnace-grade ore in response to the huge growth in blast furnace-based steel production in China over the previous two decades.

The benchmark 62% Fe iron ore produced in the Pilbara is not suitable for existing DRI processes and the quality being produced in the last decade has been falling, making it even less suitable.

Part of the solution will likely be technology combinations that allow the use of blast furnace-grade ore in DRI-based steelmaking. In Germany, Thyssenkrupp is starting to progressively replace its blast furnaces with DRI shaft furnaces plus a melting stage, which then feeds existing basic oxygen furnaces, allowing it to continue using lower-grade ore. All three of the Australian iron ore majors are developing DRI-based technology combinations that can use blast furnace-grade, Pilbara iron ore.

However, where steelmakers switch from blast furnaces and basic oxygen furnaces to the established and mature DRI-electric arc furnace (EAF) steelmaking pathway, DR-grade iron ore will be required.

The leading global producer of DR-grade iron ore – Brazil's Vale – is planning to increase its supply of the high-grade ore in response to the accelerating steel technology shift. The remainder of the 'big four' iron ore producers, operating in Australia, are now demonstrating differing responses to this trend.

Rio Tinto

Rio Tinto's Canadian operations already produce DR-grade iron ore, and Rio has signed a multi-year agreement to supply the product to Swedish steel start-up H_2 Green Steel.

H_2 Green Steel will use the DRI-EAF steelmaking pathway using green hydrogen produced on site. Construction has already begun and the company announced in January 2024 that a further US$5.2 billion in funding had been raised for the project.

While Rio continues to invest in new Pilbara mining capacity, it recently announced significant capital expenditure figures for a major new mining investment overseas that will increase global supply of DR-grade iron ore.

Simandou in Guinea, West Africa, is the world's largest untapped high-grade iron ore deposit, and Rio claims that the mining and infrastructure projects to unlock it will be the largest greenfield investment of its type in Africa. The mine has a 65% average Fe content and will produce DR-grade iron ore as well as blast furnace products with a higher Fe content than Pilbara ores.

Rio owns a 53% stake in one of the two mines under development along with its Chinese consortium partners. The company's share of investment to co-develop one of the mines' rail and port infrastructure is estimated at US$6.2 billion. A final investment decision on the project is expected in 2024.

Rio states: "Simandou will deliver a significant new source of high-grade iron ore that will strengthen Rio Tinto's portfolio for the decarbonisation of the steel industry." First production from the mine is planned in 2025, with output ramping up over 30 months to reach 60 million tonnes per annum (Mtpa).

Another mine at Simandou – whose venture partners include China Baowu – will produce a further 60Mtpa.

Rio states that the Simandou project positions it for the decarbonisation of the steel industry by allowing it to supply low-carbon, DRI-based steelmakers. It also has a growing list of development projects aimed at reducing steelmaking emissions. Despite this, Rio still does not have a measurable Scope 3 emissions reduction target. The Scope 3 emissions produced when its steelmaking customers process its iron ore dwarfs Rio's Scope 1 and 2 emissions.

Fortescue

Unlike Rio Tinto, Fortescue has set a measurable target to reach net zero Scope 3 emissions by 2040, by far the most ambitious target among its peers. As part of efforts to achieve this, Fortescue is also targeting African iron ore.

December 2023 saw the company's first shipment from its Belinga iron ore project in Gabon – its first ever delivery from outside Australia. Details about the quality of iron ore to be produced from this project have been thin, but Fortescue has previously insisted that "every indication we have, shows the project has the potential to be significant scale and very high-grade", and that "initial indications are that it could be similar in scale and size to Simandou in Guinea".

Fortescue revealed that the first Belinga shipment had an Fe content in the "low 60s" but noted that this delivery was more about proving the logistics train, without a focus on grade. Full evaluation of the mine is underway, with the promise of more details – which could determine the extent to which the project can facilitate low-carbon steelmaking – to come.

Meanwhile, Fortescue is already producing and shipping iron ore in Australia containing more than 67% Fe, which meets DR-grade.

The Iron Bridge project may only be the first in a series of magnetite mines that Fortescue develops. Magnetite has a lower Fe content than hematite in situ, but it is easier to process up to DR-grade. In August 2023, Fortescue Metals CEO Dino Otranto stated: "Iron Bridge is a premium grade magnetite product, not only broadening our portfolio of products and providing diversification opportunities, but is also critically important in the energy transition to make green iron."

Iron Bridge is in the process of ramping up production, though it hit a new problem in the form of a burst water pipe, which will reduce expected production in the current financial year and cost A$150 million to repair.

Going forward, magnetite looks set to play a growing role in supplying decarbonised steel operations. POSCO and Liberty Steel are planning low-carbon steelmaking projects in Australia based on magnetite and more mines are being developed.

BHP

In contrast to its peers, BHP is not targeting increased high-grade iron ore production. Its focus remains on expanding production of blast furnace-grade ore in the Pilbara.

Instead of chasing higher-grade ore, BHP's Scope 3 efforts are focused on technology developments that could allow the use of its Pilbara ore in DRI-based steelmaking, as well as carbon capture, utilisation and storage (CCUS).

BHP's insistence that CCUS will play a role in reducing steel emissions by decarbonising coal-consuming blast furnaces is hardly surprising – BHP is also the world's largest shipper of metallurgical coal. However, the retrofitting of blast furnaces with CCUS units to reduce emissions is making virtually no progress.

The German think tank Agora Industry highlights that, since 2020, virtually all steel companies that plan to build low-carbon steelmaking capacity at commercial scale have opted for hydrogen-based or hydrogen-ready DRI plants, rather than adding CCUS to blast furnaces. The 2030 project pipeline of DRI plants has grown to 94Mtpa, while the pipeline for commercial-scale CCUS on blast furnace-based operations amounts to just 1Mtpa, according to Agora.

Despite the poor track record of CCUS across all sectors, BHP is pursuing carbon capture development projects with steelmakers HBIS and ArcelorMittal.

BHP's reliance on CCUS looks highly unlikely to help it get near its "goal" to reach net zero Scope 3 emissions by 2050. As the company itself makes clear, a goal is not the same as a target. BHP does not have a measurable Scope 3 emissions reduction target.

In 2024 we can expect to see a further acceleration in the steel technology transition away from coal, and increasing pressure on companies to act on their Scope 3 emissions.

Technology developments that allow the use of blast furnace-grade iron ore in DRI-based steelmaking solutions are likely to play an important role in steel decarbonisation and hence reducing the Scope 3 emissions of iron ore miners. The continuing poor track record of CCUS means it is unlikely to play a major role.

However, at this stage of the transition it looks like increased supply of DR-grade iron ore will also be important.

Differences in long-term iron ore supply strategies are already emerging in the face of growing steel decarbonisation momentum, with some of those strategies looking more likely to prove successful than others.

Source: IEEFA-Friday Week in Review, 10 Feb. 2024

Sustainable Aluminium 101: How to Decarbonize a Critical Material for the Energy Transition

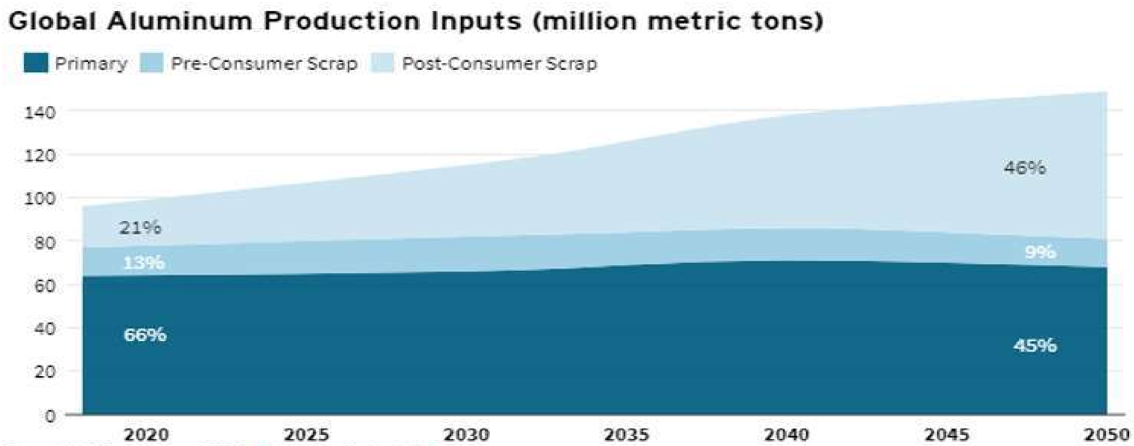
Light, strong, and highly recyclable, aluminium is a first choice for many climate-tech applications. Aluminium's lightweight yet strong properties make it indispensable to a range of industries, from cars to airplanes to solar panels. But that versatility comes at a cost. The aluminium industry is responsible for roughly 2 percent of global greenhouse gas (GHG) emissions. The vast majority of those emissions come from producing the metal from bauxite ore using electricity. China is the world's largest aluminium producer, at 55 percent of global production. But aluminium's reliance on electricity makes it ripe for rethinking and charting a path toward a renewables-powered future.

Aluminium's centrality to the energy transition is poised to increase consumption its by between 50 and 80 percent by 2050, while aluminium's emissions need to drop by 77 percent to stay within a 1.5°C pathway.

The most climate-friendly aluminium - recyclable aluminium - is produced using the least energy, and that's where the metal has a distinct advantage. Endlessly recyclable, aluminium that is reused, has a much smaller carbon impact. However, recycling will not decarbonize the sector alone as scrap is not enough to meet the growing demand for aluminium.

In order for this essential industry to thrive in a net-zero world, two things need to happen: aluminium production from raw materials must switch to renewable sources, and recycling rates need to increase dramatically.

Not all recycled aluminium is equal. In order to decarbonize the aluminium sector, it's important to separate out post-consumer aluminium from pre-consumer aluminium (e.g. the wasted ends of aluminium sheeting on the can's factory floor). The industry term for these "waste" products is scrap.



On the pre-consumer side, to reach net zero, manufacturing needs to become more efficient so that extra aluminium isn't produced in the first place. Although this is eventually recycled, we must reduce this pre-consumer scrap from 13 percent to 9 percent of production by 2050 to reach net zero.

On the post-consumer side, much more can be done. A European study found that roughly 28 percent of beverage cans on the continent end up in landfills or incinerators. On a global scale, the use of post-consumer scrap in aluminium production needs to jump from 21 percent to 46 percent by 2050 to stay in line with net-zero goals.

To incentivize the use of more post-consumer scrap, it is important to know what percentage of an aluminium product's inputs are from this end-of-life scrap. Currently, most aluminium producers just report the total recycled content in their aluminium products, making it impossible to know whether or how much post-consumer scrap was used. To overcome this challenge, buyers of aluminium products are increasingly requesting more information on the share of post-consumer scrap in their purchased products.

Equipping aluminium producers with the tools they need to transition to net-zero production will take vast amounts of capital, as well as a renewed focus on recycling.

Source: RMI Spark Newsletter, 15 Feb. 2024

Is Clean Hydrogen A Climate Solution? Depends How It's Made — and Used

Hydrogen may be the lightest element in the universe, but it could play a hefty role in decarbonizing the economy, if, it's produced and used with the climate in mind. Clean hydrogen can help decarbonize the world, but only if it's made in an emissions-free way.

Hydrogen is flexible: It can be made from coal, fossil gas or water and electricity. It can be used to fuel a car or make important chemicals like ammonia. The problem is that not all methods of production and end uses are good for the planet.

The best and worst ways to make clean hydrogen

Globally, about 95 percent of hydrogen is produced via a process known as steam methane reforming (SMR). In this approach, a producer heats water to form steam that's then reacted with methane in fossil gas to generate pure hydrogen. Planet-warming carbon pollution is the byproduct.

But there are ways to make hydrogen with low or no emissions. One method of producing so-called "green hydrogen" uses a device called an electrolyzer and carbon-free electricity to zap water and free hydrogen from oxygen. Another approach, producing so-called "blue hydrogen," uses the traditional SMR process but captures and stores the carbon emissions that result.

There's no guarantee, however, that these two methods make clean hydrogen. The carbon footprint or intensity of green and blue hydrogen depends entirely on the nitty-gritty details of a given production plant, including where it sources its fuel from.

Electrolysis could be acutely carbon-polluting if producers are allowed to draw power from coal and gas plants. What's worse, a green hydrogen production plant can eat as much energy as a medium-sized city, so if producers aren't also *adding* new clean power sources, the massively increased demand may push grid operators to fire up dirty power plants to fill the gap.

Powering electrolyzers with onsite renewable energy is squeaky clean. Hydrogen made this way is expected to emit less than 0.45 kilograms of CO_2 per kilogram of H_2 produced.

Hydrogen producers using electrolysis that don't build their own wind and solar farms will need to follow strict guidelines around the electricity they buy from the grid if they want their hydrogen to be clean. Clean power has to be added to the grid specifically to supply the electrolyzer. And, it has to be able to physically flow through the grid to reach the electrolyzer. Additionally, r has to be generated in the same hour that the electrolyzer uses it.

Producers could potentially make clean hydrogen from fossil gas by using carbon capture and storage tech. But two issues complicate this route. The first problem is that fossil gas leaks, from the well where it's extracted all the way to where it's delivered. That's harmful because methane in fossil gas has more than 80 times the warming potential of CO_2 over a 20-year period. The second roadblock is that current carbon-capture rates aren't anywhere close to desired levels. Producers would really need capture rates of 80 percent and above.

Some of the best uses for clean hydrogen will be in fertilizer production, oil refining and chemical manufacturing. These industries already rely on (currently dirty) hydrogen as a feedstock. Another high priority for hydrogen use is in steelmaking because it can displace the coking coal used to reduce iron ore to make steel's key ingredient: pure iron.

Derivatives of hydrogen, such as ammonia and methanol, will also make sense for cases when electrification isn't competitive or technically feasible. These include maritime shipping and jet aviation — forms of transportation that can be too massive and trek too far for today's lithium-ion batteries to handle. Biofuels are also likely to play a role in these industries.

What about the worst ways to use clean hydrogen? These include heating buildings, fueling cars and providing the grid power that's not stored first. Tech already exists that's far more efficient at heating homes than hydrogen is: heat pumps. Electric vehicles are expected to keep growing globally, while hydrogen fuel-cell cars are on the road to nowhere. And because roughly 70 percent of the energy is lost in conversion steps, it's much more efficient to use clean electricity directly rather than convert it into a middleman fuel that's then immediately burned for power.

By contrast, making hydrogen from excess clean power and storing it for weeks or months would be valuable. Stored hydrogen would help build out solar and wind power by providing a resilient reserve when these intermittent sources aren't available.

By 2040 we'll see clean hydrogen matched to the sectors that it can decarbonize most easily. And the worst use cases will be pushed to the fringe because they're economically uncompetitive.

Source : Canary Media Daily Newsletter, Jan, 31, 2024

Mineral Output Rises 5.1% in December

India's mineral output increased by 5.1% in December as compared to the year-ago period, the government said.

The index of mineral production of mining and quarrying sector for the month of December, 2023 at 139.4 is 5.1% higher as compared to the level witnessed in the corresponding month of 2022, the mines ministry said in a statement.

The cumulative growth rate in the mining and quarrying sector for the April-December period of the current fiscal over the corresponding period of previous financial year is 8.5%, as per the provisional statistics of Indian Bureau of Mines (IBM). In December, the production of coal stood at 929 lakh tonnes while that of lignite at 40 lakh tonnes, iron ore at 255 lakh tonnes and limestone at 372 lakh tonnes. Production of lignite, limestone, coal, bauxite and natural gas showed positive growth.

Source: The Economics Times, 23rd Feb. 2024

National Conference on Steel in Infrastructure

M/s Metalogic is organising a National Conference on Steel in Infrastructure at The Ashok Hotel, New Delhi on 16th March 2024.

IIM Delhi Chapter is a Knowledge Partner in the Conference.

The Conference is expected to be inaugurated by Hon. Minister of Steel and Civil Aviation.

Apart from the Inaugural Session, the following will be the technical sessions in the Conference:

- Building Safe & Sustainable – Roads, Highways, Waterways Terminals & Ports
- Advance structures for Smart Buildings – Residential and Commercial Projects for Smart Cities
- Public Infrastructure for Mass Transits – Airports, Railway Stations, Bus Stands and High Speed Metros
- Project Financing for Infrastructure

Members may like to participate in the Conference.

For further information in the matter the members may contact at email: mannu@metalogicpms.com & Mob. No. 7583981120.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Hon'ble Minister of Steel and Civil Aviation
Nagendra Nath, IAS
Secretary, Ministry of Steel Government of India
Maj. Gen. Ashok Kumar
DG (Works), Military Engineering Services Ministry of Defence
D. Sarangi
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Amarendu Prakash
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Hardik : 85878 72832
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Mannu : 75839 81120
Shivangi : 9634480172

Climate Change Terms

Anthropogenic — Resulting from the influence of human beings on nature.

Carbon capture and sequestration (or storage) (CCS) — Capturing carbon dioxide emissions from power plants, steel plants and other industrial sources and storing it underground.

Carbon capture, utilization, and storage (CCUS) — Capturing carbon dioxide emissions from power plants, steel plants and other industrial sources, reusing them for beneficial applications, and storing the remaining emissions underground.

Carbon dioxide removal (CDR) — Extracting carbon dioxide from the atmosphere.

Circular economy — An economic system designed to minimize waste by reusing, repurposing, and recycling materials to create a closed loop.

CO_2e — Carbon dioxide equivalent, or the amount of CO_2 that would have the equivalent global warming impact as the same amount of a different greenhouse gas.

COP — The United Nations yearly climate change conference (officially Conference of the Parties).

Demand-side management — Energy efficiency measures designed to encourage consumers to decrease their electricity usage.

Embodied carbon — The sum of all greenhouse gas emissions produced during each stage of a material's life cycle.

Global stocktake — The United Nation's inventory of the world's progress on reducing greenhouse gas emissions.

Global warming potential (GWP) — A measure of how a gas contributes to heating the earth's atmosphere, compared to CO_2 over a specific time period.

Greenhouse gases — Gases in the atmosphere that trap heat.

Green hydrogen — Hydrogen produced using renewable electricity.

Grid parity — When an alternative energy source produces electricity at a similar or lower cost to that produced by the electricity grid.

Just transition — Greening the economy in a way that is as fair and inclusive as possible to everyone concerned.

Levelized cost of energy (or electricity) (LCOE) — The average cost of energy (electricity) generation over the lifetime of the power plant including upfront costs to finance and build a facility along with its estimated lifetime costs for fuel.

Loss and damage — The damage occurred from negative consequences of climate change, usually arising from extreme weather events such as rising sea levels, hurricanes, wildfires, and others.

Nationally determined contribution (NDC) — A country's climate action plan to cut greenhouse gas emissions.

Nature-based solutions — Using natural features (e.g., gardens, parks, trees, bodies of water, and others) to improve a community's health, environment, and other societal challenges.

Negawatt — A unit in watts of electrical power saved.

Net metering — An electricity billing method that credits solar energy system owners for the electricity they produce and send to the grid.

Net-zero energy — Usually applied in a building context, it means that the amount of energy consumed by the property is equal to the amount produced — usually by having renewable energy generating on-site.

Net-zero energy ready — Sometimes known as "net-zero ready," this term is usually applied in building and construction projects. It refers to a building being designed or renovated to achieve net-zero energy levels of efficiency (will produce as much energy as it consumes), and is prepared to have renewable energy installed on-site.

Offtakers — The people or companies that will purchase the product that a new project is creating.

Performance-based regulation (PBR) — Regulatory mechanisms aimed at overcoming the incentives in traditional "cost of service" regulation that can deter utilities from investing in the resources and technologies needed to support the clean energy transition.

Performance incentive mechanisms (PIMs) — A regulatory tool to align utility investments and actions with desired policy outcomes.

Power purchase agreement (PPA) — A contract in which a developer installs, owns, and operates an energy system on a customer's property, and the customer buys the energy at a pre-negotiated price.

S-curve — A trajectory of growth that shows that the adoption rate of innovations is non-linear — slow at first, then rapidly rising before flattening out again as it reaches market saturation.

Source: RMI Spark Newsletter, 01 Feb. 2024

Know Your Members

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Working Area	Iron & Steel industry - Iron Ore Pellets
Academic record	BE (Metallurgical), IIT Roorkee; Diploma in Business Management from AIMA; Graduate ship in Industrial Engineering from IIIE, Bombay.
Working Experience	52 years (SAIL-Bhilai Steel Plant, R&D Centr, Corporate Planning. Scientist G at TIFAC, Department of Science & Technology, Professor at IIFT, Pellet Manufacturers Association of India)
Technical Expertise	Metallurgical Engg., Technology and Innovation Management
Achievements	* Visiting Faculty on Technology Management at 'State University of New York' (SUNY), Buffalo, USA * Member of the Empowered Committee, Ministry of Steel for evaluating new R&D projects for SDF funding * Invited by European Union (EU) to their HQ at Brussels to evaluate R&D Proposals from different countries for EU funding
Awards	Group Study Exchange Award of Rotary International to visit USA and give lectures in Rotary Clubs; ADB award to set up a 'Technology Watch Centre" at National Science Foundation, Colombo, Sri Lanka. "Best Oral Presentation" on 'Indian Iron Ore Pellet Industry' at the ATM, IIM, Bhubaneswar
Publications	Titanium - A Metal of the Future, Technology Vision 2020 on Metals & Materials Series on Non Ferrous Metals with IIM
Membership of Professional Bodies	Life Member of The Indian Institute of Metals (LM 49278)